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INTRODUCTION

The notion has been around a long time that numbers and logic ought to rule the universe. Until recently, however, only a few philosophers have had much faith that this might actually come to pass. Quantitative scientific analysis admittedly had a place in engineering, and in science itself, but for determining decisions and policy in the world of affairs, it had a very limited value; that world would continue to be governed by tradition, judgment, intuition, and experience. Wisdom, insight, and perseverance made Churchill, Napoleon, and Edison great, not calculation.

The systems approach--and I'm encompassing within this term systems analysis, operations research, management science, systems engineering and the analytic activities associated with aerospace technology--represents a considerable challenge to this point of view. It offers a way to bring scientists and the methods of science into domains where decisions have been almost the exclusive prerogative of politicians, lawyers, and entrepreneurs. To date, moreover, the systems approach has met with fair

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success; in commerce, industry, and defense, systems analysis and other scientific aids to decisionmaking are well accepted--even extolled--although not without some notable critics. Elsewhere, in attempts to deal with problems of public policy, the results are at least promising enough to generate considerable clamor for more.

One hears that to meet the many challenges of our contemporary society--the growth of organized crime, the pollution of the environment, the urban sprawl, the world food shortage, the international balance of trade, the inadequacies of the U.S. Post Office--one need only turn to the systems approach.

However, in spite of what we hear, it is not clear that the systems approach as practiced today--say, in the aerospace industry--is likely to be a spectacular success with any of these, even the last. This is not to say that aerospace technology, operations research, and systems analysis cannot be successfully applied to specific, well-defined subproblems and subsystems of our state and local governments. But total problems are another matter. Even the Post Office gives us trouble. We may be able to design an efficient system but as yet we have no algorithms for finding ways to overcome the resistance offered by tradition, legal restrictions and a host of privileged interests that inhibit radical or even morphological change.

Nevertheless, the outlook is hopeful. My belief is that the systems approach can contribute significantly to planning and policy formulation by federal, state, and local governments, provided four developments now underway are carried considerably farther. In two of these, the analysts must themselves take the lead; the other two are largely up to the policymakers.

What the analysts must do is (1) further enlarge their concept of what constitutes acceptable analysis and (2) seek ways to adapt it to a new decisionmaking environment.

What public officials must ~~do~~ is (3) tie the systems approach into the policymaking system, giving it status and responsibility, and (4) provide the support that is needed to make proper use of it.

I will elaborate on each of these ideas but first I need to say something about the nature of systems approach and how it is currently practiced.

THE NATURE OF THE SYSTEMS APPROACH

What do I mean by a systems approach? It is not a method or technique; nor is it a fixed set of techniques; but rather a concept, or a way of looking at a problem. It is identical with what I have called systems analysis elsewhere.* That is, it is a practical philosophy for carrying out decision-oriented interdisciplinary research, a perspective on the proper use of the available tools, a way to investigate how best to aid a decisionmaker faced with complex problems of choice under uncertainty. Operations research, management science, systems engineering, and aerospace technology are either encompassed as techniques or identical, depending on one's interpretation of these disciplines.

The idea is not new and, in the abstract, what needs to be done is simple and rather obvious. In "taking a systems approach," one must strive to look at the problem as a whole and in its proper context. Three sorts of inquiry are involved, any of which can modify the others as the work proceeds. There is a need, first, for a thorough investigation of what the objectives of the man or institution you are trying to help are (as opposed to what he originally thinks they may be) and of the measures of effectiveness and criteria for deciding how to choose among the alternatives that promise to achieve those objectives. Second, the possible alternatives need to be investigated for feasibility, risk, and cost (in all its aspects), and then compared, in terms of the outcomes that follow from their choice. In addition, if it appears that we can do significantly better or if we cannot achieve the objectives, there must be an attempt to

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*In reference (1). Most of the aerospace community, however, interprets systems analysis much more narrowly, restricting it to the application of quantitative economic analysis and cost-effectiveness methods to such matters as vehicle design and the determination of force composition and deployment.

design further alternatives and select other goals. The concept of a systems approach is not new, but what may be novel is the emphasis: on a long-run time horizon; on looking at the entire problem as a whole; on the clarification of objectives; on the search for alternatives; on explicitness; on the recognition of uncertainty; and, above all, on the use of quantitative models to make comparisons insofar as this can be done.

Systems analysis, operations research, and similar techniques have functioned well for industry and defense, areas that lack the benefit of a comprehensive theory for guiding action, by relying on the systematic utilization of a large body of only partly articulated and largely intuitive judgment by experts in the field. The standard research technique for such utilization is that of constructing an appropriate model of the situation. The systems approach is now being called on in public policy areas precisely for the same reasons it was called on for industry and defense--a theoretical foundation for guiding action is lacking. And again we must rely on model building.

Without exception, insofar as I know, writers on the systems approach and related techniques recognize the importance of model building even though they may not always appreciate its full role. They agree that the major element in tackling a problem is to construct and use a model, tailored both to the situation under study and to the question being asked. The "distinctive approach" as the Operational Research Society of Great Britain put it in their definition of operational research, "is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls." Now I'm not certain how the word "scientific" should be interpreted beyond a plea for maintaining the same traditions, but I know how it *is* interpreted.

The most used models, often the only type even considered by the usual practitioneer are scientific in a very narrow sense, that is, they are mathematical, expressing through a set of mathematical equations, or a computer program, the effectiveness and costs of alternative actions in terms of variables which discriminate between the options or alternatives and parameters which enable us to investigate the contingency or context. By operating with such models, either analytically or numerically, the consequences of alternative choices are determined.

Actually, systematic analysis of largely routine operations using models of this type is widespread throughout the civil government, at all levels. For example, it may help to determine how Post Office trucks should be routed to collect mail from deposit boxes, or whether computers to handle inventories should be rented or purchased, or how many of each type of approved textbooks should be distributed to a given school. Such questions are typically an attempt to increase efficiency in a situation where it is clear what "efficiency" means. The situation can be modeled, or, even better, with minor modifications, the problem can often be made to fit a standard model and the analysis reduced to the application of a well-understood mathematical discipline such as linear programmi .g or queueing theory. An "optimum" solution is then obtained by means of a systematic computational routine. The queueing model, for example, may be adapted to many operations of freeways, airports, service facilities, maintenance shops, and so on. In many instances, such models may actually tell the client what his decision or strategy ought to be.

Models in this tried but restricted sense are particularly difficult to create when political and social factors predominate. Some examples: how much of the city budget should be allocated to welfare and what portion of that spent on outpatient clinics, or whether local transportation

needs are better served by a rapid transit system or by more and higher performance freeways, or if there is some legislative action that might end the increase in juvenile delinquency. Such questions involve more than the allocation of resources. Here, rather, the objectives or goals of the action to be taken must be determined first. It is not clear that "more efficient" has a meaning in these problems and the difficulties almost always lie more in deciding what ought to be done than in how to do it.

In industrial and military applications the problem is far more likely to deal with a completely man-made and directed enterprise--a manufacturing process, a weapon system, a railroad network--something that was designed with a purpose in mind and has a structure that follows the laws of engineering and economics. Goals can be defined, authority is clear-cut and cooperative, and the underlying design can be discovered and modeled. In contrast, an attack on problems of air pollution, urban renewal, vocational rehabilitation, or criminal justice, involves working with goals that are obscure and conflicting, where authority is diffuse and overlapping, and where the structure has grown without conscious design. To discover the underlying model may require the same sort of profound digging that is required to determine something like the role of hormones in regulating body functions. The act of collection may even bias the data. It is not surprising, therefore, that attempts to build quantitative models with which one can optimize in the conventional sense tend to fail. But this does not mean that we may not be able to find an unconventional scheme to fulfill really essential functions of the traditional model. Unfortunately, such schemes are not always accepted, or at least not much exploited in standard practice. To change this may require that we enlarge our concept of what a model contributes, if only to escape the view that it is simply a device to generate values of a "payoff" that can be used to determine preference.

The important function of a model in the type of analysis we're considering is to provide a way to forecast the outcomes that follow alternative actions and, possibly, to indicate a preference among them. A mathematical formulation with which one can optimize is an extremely valuable aid to this process but it is not crucial; there are other routes. What is crucial to every decision is reliance on expert judgment and intuition. This reliance permeates every aspect of the systems approach--in limiting the extent of the system, in deciding what hypotheses are likely to be more fruitful, in designing the model, in determining what the facts are, and in interpreting the results. The great virtue of model building is that it provides a systematic, explicit, and efficient way to focus the required judgment and intuition.

A model, by introducing a precise framework and terminology, serves as an effective means of communication, enabling analysts and various experts* to exercise their judgment and intuition in a well-defined context and in proper relation to each other. In addition, it provides feedback to guide the participants in the revision of their earlier judgments. It is these features of the model that are essential to its role in supplying a route from hypotheses to prediction, not how explicitly it simulates the real world or whether or not it provides a formal or quantitative scheme for optimization.

The realization that this is the case is neither new nor startling. Operational gaming, that is to say, exercises in which the participants interact by playing roles that simulate individuals, or factions in a society, or even such things as sectors in an economy, is a first step away from the traditional model. Its predictive quality is very clearly a function of the intuitive insight provided

*A loose term, applied to anyone whose guidance and knowledge is relevant.

by the participants. By allowing for the introduction of judgment at every stage, a game provides an opportunity to take into account intangibles often considered completely beyond the reach of analysis. Both the expert on the control team and the player can let their decisions be influenced by their appraisal of the effects of the simulated environment. For example, the player can take into account how the success or failure of an economic plan may depend upon assumptions about a population's willingness to accept a change in diet or the flexibility of the political structure to accommodate a new power bloc. In any analytic formulation or computer simulation, factors of this type must be anticipated and decisions about them made in advance; in a game they can be made _seriatim_, and in context, as the need arises.

But gaming--even thought it sacrifices optimization--still retains the representative features of the traditional model. My contention is that there are advantages in using approaches that sacrifice representation also. This brings me to my first point.

AN ENLARGED CONCEPT OF MODEL

My suggestion is that we take a broad view of the traditional concept of model, accepting as a substitute any device that provides a means to predict and compare the outcomes of alternative actions, regardless of its representative features or how efficient it is at optimization. Calling such a device a "model" in the context of systems analysis and operations research would, I think, help to counter the bias toward mathematical models acquired by so many analysts through their education and work with industry.

To illustrate that there are real advantages in using models of this extended type, a discussion of one such model, the Delphi procedure, and an outline of how it might be used to tackle a problem with considerable social and political content should suffice

Delphi is an iterative procedure for eliciting and refining the opinions of a group of people by means of a series of questionnaires, a "framework" that replaces the representative model. In practice, the group would consist of experts or especially knowledgeable individuals, possibly including some of the responsible decisionmakers themselves. The idea is to improve the usual panel or committee approach in arriving at a forecast or estimate by subjecting the views of the individual participants to each other's criticism in ways that avoid face-to-face confrontation. To this end, the process of deliberation is controlled, through feedback, by a steering group that preserves anonymity and computes the group response by using some form of averaging.

Anonymity serves to minimize the influence of vocal and persuasive individuals on group behavior. Also by making all interactions between respondents go through the steering group, "noise"--irrelevant or redundant material that obscures the directly relevant material offered by the participants--can be reduced.

The use of a statistical index, usually the median, to represent the group opinion is a further device to reduce group pressure toward conformity. No particular attempt to force unanimity among the respondents need then be made, and a spread of opinions on the final round is the normal outcome.

The simplest application would be one that requests estimates of a set of numerical quantities, e.g., the dates at which technological possibilities will be realized or the costs they will generate. The results of a first questionnaire asking for the quantities desired would be summarized in terms of, say, the median and inter-quartile range of the responses. This summary, possibly with additional information, would then be returned to the original respondents with a request for revision of first round estimates where appropriate. On additional rounds, respondents would be asked for further revisions and also to justify their estimates. These revisions and justifications are summarized, returned, and counter arguments requested. On further iterations, additional reappraisals and arguments are collected. This basic pattern obviously could have a great many variants, only a very few of which have been investigated.

The Delphi procedures--anonymous response, iteration, controlled feedback, numerical estimates, statistical "group response"--promise to become a highly effective means for getting information out of a group of experts. Experiments in which the respondents seek answers to "factual" questions indicate, for example, that:*

*For the full set of conclusions to these experiments carried out at RAND in 1968, see reference (2).

1. Face-to-face discussion is not as efficient as more formalized communication.
2. Improvement in accuracy of estimates may be expected with iteration.
3. Accuracy improves when estimates of range as well as of single points are requested and supplied.

Major credit for development of Delphi must be given to Olaf Helmer and Norman Dalkey of RAND.* My ideas originated in their papers [3-6]. Although still experimental, Delphi has been used, among other tasks, to study educational innovations [7], to survey technological developments of interest to a commercial organization [8], and to provide short-range forecasts of business indices [9]. Except for the last, however, the value of these exercises is hard to assess and further experimentation is urgently needed.

To illustrate the use of Delphi for systems analysis, let me outline how it might be applied to a typical cost-effectiveness problem--allocating a budget for crime prevention.**

On the first round, one might ask a panel drawn from the policymakers, their advisors, experts familiar with the area, and possibly others who are merely interested, to list projects that they feel should be included in any program. There will always be alternatives competing for funds: more police, better training, changes in court and parole procedure, new laws, and so forth. Not all promising projects can be financed; the problem is to devise a scheme to suggest and compare alternatives, and to select

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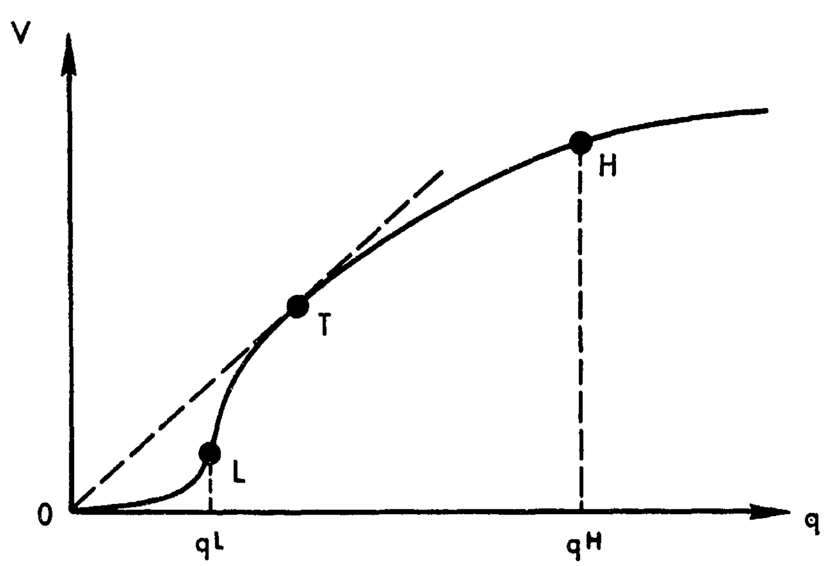
**For an extended description of another possible application, see [1], pp. 335-342.

a preferred allocation of the freely disposable residue of the budget.

A project is rarely, if ever, of an all-or-nothing kind; that is, there is associated with it a degree to which it can be executed. The problem therefore is not merely to select the best projects but also to decide how much of each. In general, the value, V, that will be obtained from the application of a project, will typically appear as a function of its degree of adoption, q, in the form of an S-shaped curve, as in the figure.



For each project, the Delphi procedure can then be used to obtain estimates from the panel regarding two points on this curve: the value q^L below which adoption of the project would be pointless, and the value q^H above which the marginal benefits are so small as to make adoption wasteful. (One would expect many estimates of q^H to be zero, indicating total rejection of the project.) The unit of measurement of q is best in some natural unit, such as number of patrol cars; but if this is not possible some monetary unit may be used.

After reaching the best estimates of q^L and q^H, the next step is to work out and estimate the cost of the project at each of these values of q. (Of course the expected cost of a project depends to some extent on other projects that are adopted, but we must ignore this interaction at this stage.) We would probably not need to call on Delphi here, since cost analysis, like engineering, has a good theoretical foundation.

Finally, comparative estimates of the effectiveness of each project (at the proposed levels of adoption) must be obtained. This requires the establishment of measures of effectiveness, which is not always easy since the evaluation of some projects will depend upon subjective preferences. However, one way to set about this task is as follows: assume a scale of effectiveness from zero (i.e., with only the precommitted projects in existence) to 100 (representing the panelists' assessment of the optimum effectiveness obtainable from the budget). Each panelist would then give his assessment on this scale of each project implemented at extent q.

If the estimates of the panel are then combined, the directors are now in a position to construct, for each project, a curve of effectiveness vs. cost, and the budget can be systematically drawn so that the associated values of the specified quantities allocated form a maximum.

This approach has many deficiencies. For one, were the budget to be implemented, it is unlikely that the actual costs and benefits would be identical with those determined separately for each project in isolation. Consequently, one or more iterations are called for so that the participants may take into account the existence of other projects at approximately the proper level. There may be more serious difficulties in this application, however. The results from any Delphi process, of course, depend on two critical factors: the choice of the panel

and the way in which the process is implemented. Here, the choice of "policy advisors" and "experts in the area" for the panel may bias the outcome toward conservatism in dealing with a situation where the only hope for improvement may lie in innovation. And the topic is shot through with judgments about values and goals that one may not like to trust to such a panel, let alone to the group of analysts conducting the exercise.

Much remains to be learned about Delphi and the use of expertise. For example, we would like to know how much of the convergence that takes place is induced by the process itself rather than by elimination of the basic causes of disagreement. Placing the onus of justifying their responses on the respondents clearly tends to have the effect of causing those without strong convictions to move their estimates closer to the median, for those who originally felt they had a good argument for a "deviationist" opinion may tend to give up their original estimate too easily; this may result in increasing the bandwagon effect instead of reducing it as intended.

The potential usefulness of the Delphi approach is much wider than the published applications indicate. Extensive interest has been demonstrated by industrial and urban planners, research managers, policymakers (in the U.S. government and elsewhere) in the promise of Delphi procedures for technological forecasting, corporate planning, organizational decisionmaking, and policy evaluation. Suggested applications range from the drafting of diplomatic notes to long-range political forecasting. Unfortunately, many of the applications being considered are marginal at the moment, in the sense that greater effectiveness of Delphi procedures over more conventional techniques has yet to be demonstrated.

Plans for further investigation of the Delphi technique at RAND take several directions, in addition to our general

effort to develop models for what goes on and use them to improve the procedure.

In view of the accelerating use of Delphi procedures by such a wide spectrum of public and private institutions, two topics are of immediate practical concern: forecasting technological and social events and value judgments.

With regard to forecasting, experimentation in the past with short-range predictions suggests that the conclusions from factual estimation experiments apply to them as well; but this presumption needs confirmation. Not much can be done experimentally with long-range forecasts as far as accuracy is concerned, but one may be able to investigate the reliability of such forecasts, in the technical sense of consistency of judgments over similar groups of "experts."

In the area of value judgments the introduction of some objectivity can have extensive and important repercussions. As with long-range prediction, there is not too much that can be done with regard to "accuracy," but the reliability and stability of group evaluation can be investigated experimentally. There is evidence from applied exercises that iteration produces convergence with value judgments, but whether this convergence is stable or capricious is not visible from the uncontrolled exercises. Finally, a large amount of diffuse "experience" with Delphi suggests that the structural properties of the procedure (anonymity, systematic approach, controlled feedback, "total" participation, statistical definition of group response) leads to an enhanced acceptance on the part of individual participants beyond what obtains with more conventional (e.g., face-to-face) procedures. This is clearly a valuable characteristic, especially if the group is one of decisionmakers or others whose concurrence is required for the implementation of policy and is amenable to study.

Imperfect as it is, the Delphi process or some further modification appears to promise a way to investigate many problems with a high social and political content. Because it can be used to estimate the consequences of alternative actions, and thus substitute for a conventional model, Delphi offers a hope of introducting the systems approach into a range of problems where such models cannot be formulated.

Now for the second modification that is needed.

ADAPTATION OF THE ANALYSIS TO THE ENVIRONMENT

In military or industrial situations, systems analyses and operations research studies are ordinarily designed and carried out, although perhaps not consciously, as if they were to assist an individual decisionmaker (with the authority to implement the findings) to make a discrete decision. This may be far from a satisfactory formulation for the analysis of most public policy problems. The policymaking environment is such that there are likely to be many participants in any given decision, most of whom can counter any recommendation but none with the authority to implement it alone. Consequently, it seems desirable to adapt the analysis to the changed nature of the decisionmaking system, to pay specific attention to politics and political phenomena and, in particular, to consider, as part of the analysis, the problem of how implementation is to be attained.

In 1966, for example, Edmund G. Brown, then governor of California, sought to improve public administration there by an infusion of that new management technology, systems analysis. Contracts were let with a number of aerospace firms to investigate transportation systems, criminal justice and the prevention of delinquency, the flow of information needed for the state's operation, the control of management of wastes, regional land-use information systems and the state's social welfare operations. Nothinq much has resulted from these in the way of action. But it is interesting to note that somewhere among their findings, each study calls for an increase in centralized authority; some go so far as to ask that some sort of "environmental" manager or czar be set up.

The pollution control and waste disposal study, for instance, indicated that a profit-making regional waste-disposal system could handle all the liquid and solid waste matter of the entire San Francisco Bay area, converting

it to salable products, and reduce or eliminate the tax burden required to support this function. To implement such a system, the study recommended a centralized authority, independent of city, county, or state boundaries, capable of making decisions for the region as a whole on all matters that might affect the system, encompassing finance, organization, control, and the participants. In the past, such recommendations have not worked out very well because, at best, the central authority set up has been a temporary committee of local representatives without true legal decisionmaking authority.

In a certain sense, however, the lack of authority to implement is not the only serious handicap facing a systems approach. It is not only very difficult to create the kind of inter-governmental body required to execute proposed systems solutions on a regional basis but it is sometimes hard to find an authority that can thoroughly review and properly criticize an analysis that cuts across political boundaries and suggests a regional solution.

It often seems to be implied and sometimes even said, that one purpose in introducing systematic analysis into the public policy area is to eliminate politics from decisionmaking. If so, the effort is doomed to failure. To a man in public office any solution that extends past his term is long range, and he must consider his future. It is, in fact, not only impractical, but unappealing, to eliminate politics and bargaining in a nation that guards its freedom from centralized authority. The introduction of an analytic capability is likely to change the political power structure. So much so that the fear is sometimes expressed that a widespread dependence on analysis will lead to a desire to strengthen central authority. What we need is to learn how to do analysis that can be used successfully in a situation with many decisionmakers and diffuse authority.

Just how to change is not clear. The ideal, I suppose (although I don't know how the analysis should be carried out), is to provide the responsible decisionmakers with the means to get together and bring themselves to the proper conclusions. This may mean, for example, advising on broad policymaking strategy rather than on single discrete policy actions or investigating the bargaining positions and internal needs of an organization.

In a recent book [10], Y. Dror, of Hebrew University, makes several suggestions for improving policymaking. These are based on his contention that public policy is made by a system, the public policymaking system, in which a large number of different kinds of units interact in a variety of partially stabilized but open-ended modes. Action takes place by a process of complex interactions between a large number of components. There are a variety of paths leading to any action, some hidden and only partially known to all the participants and others open and surrounded by a great deal of noise. Proposals for changes must surpass many hurdles. One suggestion Dror makes is that each proposed recommendation be examined in the analysis for political feasibility, that is, the probability that it will be sufficiently acceptable to the various secondary decisionmakers, executors, interest groups, and publics that it can be translated into action. Political feasibility depends on the power structure in which the parties affected are involved and on the ability of the policymakers and the policy itself to recruit support. In addition, Dror points out how important it is that the analysis cover all aspects of a policy even if it requires the use of far less desirable means to arrive at the recommendations--for example, by measuring output in terms of input, say, by using the professional qualifications of the policymakers to estimate the quality of their policy.

I am convinced that Dror is right and that in selecting an "optimal" policy, political feasibility must be considered in the analysis. Here I am reminded of the first item in that somewhat remarkable selection of readings [11], compiled as part of their investigation of PPBS by the Senate Subcommittee on National Security and International Operations under the title <u>Specialists and Generalists</u>: "The Mice in Council" from Aesop's Fables. It illustrates how crucially important it is that analysis consider feasibility.

> "A certain Cat that lived in a large country-house was so vigilant and active, that the Mice, finding their numbers grievously thinned, held a council, with closed doors, to consider what they had best do. Many plans had been started and dismissed, when a young Mouse, rising and catching the eye of the president, said that he had a proposal to make, that he was sure must meet with the approval of all. "If," said he, "the Cat wore around her neck a little bell, every step she took would make it tinkle; then, ever forewarned of her approach, we should have time to reach our holes. By this simple means we should live in safety, and defy her power." The speaker resumed his seat with a complacent air, and a murmur of applause arose from the audience. An old grey Mouse, with a merry twinkle in his eye, now got up, and said that the plan of the last speaker was an admirable one; but he feared it had one drawback. He had not told them who should put the bell around the Cat's neck."

Now let me turn to things public officials must do before the systems approach can make a really significant impact on the public policy area.

ANALYSIS MUST BE GIVEN RECOGNITION

Scholars and citizens have been analyzing government programs for centuries, usually without noticeable results, even when their techniques were excellent. But suggestions for improvement, whether they originate in a letter to an editor or from a well constructed study by an established institution, to lead to action must not only reach the right people but surpass some attention threshold. Even then, if the idea hasn't reached some critical mass, it can be neutralized by adjustments elsewhere in the bureaucracy before it can influence the system. To become a really effective part of the policymaking process, the systems approach must be established as part of it so that consideration of its recommendations is automatic.

At the Federal level, the introduction, the Planning-Programming-Budgeting System (PPBS), was designed to do this.

This system, ideally executed (something that may never be achieved) would provide:

(i) A set of program options, presented in a format that emphasized the goals these programs were designed to achieve. The presentation would indicate, for each alternative over an extended time period, what the money would be spent to accomplish...say, recreation, job-training, fire-prevention, and so on--as opposed to how it would be spent--for things like rent, transportation, printing, and paint. The need for choice would thus force the decisionmakers to consider explicitly whether or not they are selecting the best policy and directing their resources to the best use.

(ii) An analytic process to discover and design alternative programs, estimate their costs and effectiveness, rank them on various criteria, and supply arguments pro and con.

(iii) A data information system to tell the policy-makers how their programs are getting along and to provide material for analysis.

The important characteristics--emphasis on objectives, on a number of options, and on an extended time horizon force a dependence on analysis. This system is in marked contrast to conventional U.S. government budgeting which, until the introduction of the new system, tended to present a single plan, no analysis, a short time horizon, and to emphasize what was to be bought rather than what was to be done.

Program budgeting has been a long time in winning acceptance in the United States. Historically, suggestions for federal program budgeting date at least from 1912 when a commission reporting to President Taft proposed that a budget bureau be established and that government agencies present their budgets along program lines. More recently, two Hoover commissions seeking to improve federal management have recommended the adoption of this type of budgeting. Also, even before Mr. McNamara introduced it to the Department of Defense, other agencies had some form of this type of budgeting.

The McNamara system thus was not invented by Mr. McNamara, If patent rights were to be assigned, those would belong to a group of economists working at The RAND Corporation in the years 1948 to 1960. In particular, the ideas were first proposed in essentially the above form by Mr. David Novick of RAND's Cost Analysis Department and were brought to the Defense Department in 1961 by Charles Hitch when he became Assistant Secretary of Defense, Comptroller. What was new was the emphasis on analysis and the introduction of concepts and procedures by which analysis could be systematically applied to the processes of major decisionmaking.

Centering this management system on the budget is another inspired perception of the obvious. The common denominator of all government decisions is that whatever else they involve, they also involve money. The budget is, therefore, the inevitable vehicle within which hard decisions involving competing claims for resources are made.

President Johnson ordered PPBS installed throughout the Federal government in 1965. He called the new system revolutionary, saying it would make the participants (1) define clearly the major objectives of their programs, (2) apply systematic analysis to the alternative ways of accomplishing these objectives, and (3) plan their spending for a long range period as well as for one year ahead. Now this doesn't sound revolutionary, merely sensible.

In 1969 President Johnson was still enthusiastic, crediting PPBS with substantially improving the basis for decisionmaking within the executive branch. His January 1969 budget message recognized the impetus given to analysis by the new system:

> "The introduction to PPB has provided an impetus toward increased use of formal analysis in the decisionmaking process. The development and consideration of alternatives has been stepped up, both in the programming stage and at the budget decision stage. The emphasis on cost effectiveness analysis as part of the analytical effort has drawn attention to ways of achieving given objectives at least cost, or attaining maximum results from given outlays. Benefit/cost analysis, which had been previously practiced chiefly in the military agencies and the water resources field, is now underway on various programs in most major agencies of Government.
>
> As experience has been gained, the various elements of the PPB approach and the annual budget process gradually are being more effectively interrelated, so that the analytical results of PPB are playing a greater role in decisionmaking for the annual budget."[12].

Most observers would regard the President's remarks as presenting far too rosy a picture. PPBS has not really been tried on a government-wide basis; trained manpower to carry out the analysis was lacking and, since in many departments and bureaus its full implementation would change the power structure drastically, opposition developed, and the concept was eroded in various ways. For instance, this year, the requirement for specification of goals, probably the most important aspect of the whole idea, was essentially abandoned.

Deciding first on the program and then on the budget rather than first on the budget and then on what can be done is a useful idea. But merely to know, say, that one is planning to spend $100 million for salary, wages, travel, transportation and equipment for employees of the Office of Education, does not in itself provide information as to whether the results of such activity are going to be worth the expenditure. Here's where systems analysis comes in. Without it, the planner can at most have good intentions. The decisionmaker who seeks to spend $100 million for retarded children is using $100 million that, through reduced taxes, could be used for private expenditure, or for other educational programs, defense, mental health, etc. Analysis can help him compare what the $100 million is buying in each alternative. Still higher decision-makers can then use analysis to consider what that sum would buy if spent on other programs.

My last point is that, if the advantages of the systems approach are really to accrue to the public policymaker, there must be a capability to carry out the required analysis.

A STRONG ANALYTIC CAPABILITY MUST BE SUPPORTED

It is universally agreed that methodology is not enough. The analyst, or his team, must know, or learn very quickly, a great deal about the subject of his analysis. Public policy problems are broad in scope; they usually require contributions from many disciplines. A capable staff with varied background is needed to provide information, to define criteria and objectives for programs, to invent new alternatives, and also to develop analytic tools. In addition, because effective analysis is not a one-shot proposition but a dialogue that gets sharper as it goes on and on between the staff and the policymaker, the staff must be available for consultation and to answer questions.

Where should such a capability be located and how supported? Not completely within and by a single governmental entity, for the analysts must be free from political and organizational bias and able to think beyond what is politically acceptable; not completely in and by industry, because its knowledge and influence depends on privileged relations with the government and with competing industries; and not solely in the universities, because the studies usually require an interdisciplinary approach with close cooperation between many skills, something difficult to achieve in that environment. And it must not be a single institution, for its own biases may then dominate. The answer is a mixture; a number of independent research institutions maintaining close relations with government, industry, and the universities but independent of them, plus special staffs attached to bureaus, departments, and legislative bodies.

In testimony before the U. S. Senate, Alain C. Enthoven, then Assistant Secretary of Defense, remarked that in their experience "research funds in these fields are likely to be better spent supporting research institutions containing groups of scholars from a variety of relevant disciplines

oriented toward the problems rather than on individual scholars who are more likely to be oriented toward the exercise of the academic specialties" [13].

Even when a major portion of the studies is policy oriented, there needs to be a large program of research that explores technology, methodology, and the sciences, including the social sciences. Such studies are not only valuable in their own right, they create a base for the policy studies. In order to carry on such work, the activity needs both a broad charter, one that enables a line of research to follow its findings to new areas of relevance, and a flexible organization that can bring social and political scientists into close cooperation with engineers and physical scientists.

IN CONCLUSION

There are critics who see dangers in the systems approach and there are dangers where the critics see them. Many factors fundamental to public policy are not subject to any sort of quantitative analysis. Even though systematic procedures exist (Delphi is one possibility) for handling factors that cannot be quantified, unless an effort is made to overcome the analysts' bias toward quantitative and mathematical models, we may find the more elusive political and social aspects neglected, improperly weighted, or even deliberately set aside. We have not and never may be able to make the systems approach a pure, rational, coldly objective, scientific aid to decisionmaking--only one far more so than its alternatives. But the systems approach is not a static concept--new procedures and techniques are being constantly proposed--and thus there is hope. If it is to be effective in the area of public policy, however, not only must its recommendations be good, but when they are, it must also be possible to implement them. A good analysis requires a capable staff, but implementation is far more likely to follow if the work explicitly considers the problems of acceptance and is carried out by a staff that is, in addition, recognized and supported as part of the public policymaking system. Its recommendations are then not easily neglected or shunted aside.

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